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Unequally Unequal? Contextual-level status inequality and social cohesion moderating the association between individual-level socioeconomic position and systemic chronic inflammation

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ABSTRACT

Background: Status inequality is hypothesised to increase socioeconomic inequalities in health by creating an environment in which social cohesion erodes and social comparisons intensify. Such an environment may cause systemic chronic inflammation. Although these are often-used explanations in social epidemiology, empirical tests remain rare.
Methods: We analysed data from the West of Scotland Twenty-07 Study. Our sample consisted of 1977 participants in 499 small residential areas. Systemic chronic inflammation was measured by high-sensitivity C-reactive protein (hs-CRP; <10 mg/L). An area-level measurement of status inequality was created using census data and contextual-level social cohesion was measured applying ecometrics. We estimated linear multilevel models with cross-level interactions between socioeconomic position (SEP), status inequality, and social cohesion adjusted for age and gender. Our main analysis on postcode sector-level was re-estimated on three smaller spatial levels.
Results: The difference in hs-CRP between disadvantaged and advantaged SEPs (0.806 mg/L; $p = 0.063$; [95%CI: −0.044; 1.656]) was highest among participants living in areas where most residents were in advantaged SEPs. In these status distributions, high social cohesion was associated with a shallower socioeconomic gradient in hs-CRP and low social cohesion was associated with a steeper gradient. In areas with an equal mix of SEPs or most residents in disadvantaged SEPs, the estimated difference in hs-CRP between disadvantaged and advantaged SEPs was −0.039 mg/L ($p = 0.898$; [95%CI: 0.644; 0.566]) and −0.257 mg/L ($p = 0.568$; [95%CI: 1.139; 0.625]) respectively. In these status distributions, the gradient in hs-CRP appeared steeper when social cohesion was high and potentially reversed when social cohesion was low. Results were broadly consistent when using area-levels smaller than postcode sectors.
Conclusions: Inequalities in hs-CRP were greatest among participants living in areas wherein a majority of residents were in advantaged SEPs and social cohesion was low. In other combinations of these contextual characteristics, inequalities in systemic chronic inflammation were not detectable or potentially even reversed.

1. Introduction

Two contextual-level social characteristics and their effect on health have received much attention over the course of the last two decades: income inequality and social cohesion (Wilkinson, 1997; Wilkinson and Pickett, 2010, 2018; Kawachi and Kennedy, 1997, 1999; Pickett and Wilkinson, 2015; Muntaner and Lynch, 1999; Muntaner et al., 1999). The extensively researched, yet contested, collection of hypotheses underpinning their relevance for population health includes the “income inequality hypothesis” (Delhey and Steckermeier, 2020), “psychosocial

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theory" (Mackenbach, 2012), and "status anxiety hypothesis" (Layte et al., 2019; Layte and Whelan, 2014), proposed by Wilkinson (Liu et al., 2017b) in the 1990s. In brief, the key assertion is that higher (income) inequality creates a social environment wherein status competition thrives, stressful social comparisons and thus feelings of inferiority intensify, and social cohesion erodes (Wilkinson and Pickett, 2017, 2018; Buttrick and Oishi, 2017; Rodriguez-Bailon et al., 2020). This, in turn, increases the importance of individual-level socioeconomic position (SEP) for health outcomes and thereby may explain larger health inequalities between advantaged and disadvantaged SEPs. However, income inequality is plausibly not only affecting health via psychosocial mechanisms but also through a 'neo-materialist' pathway. In this interpretation, association between income inequality and health is caused by underinvestment in social infrastructure and services in more unequal societies that stem from historical and cultural processes, as well as inegalitarian patterns of political participation (Lynch et al., 2001, 2004).

1.1. Socioeconomic position, systemic chronic inflammation, and status inequality

While many pathways connect SEP to health outcomes, stressful social experiences, like social evaluation, get 'under the skin' via a complex interplay between the sympathetic nervous system (SNS), the hypothalamic-pituitary-adrenal (HPA)-axis, and the innate immune system (Vineis et al., 2020; Slavich and Irwin, 2014; Marsland et al., 2017; Segerstrom and Miller, 2004; Marmot and Sapolsky, 2014; Slavich and Cole, 2013; Kubzansky et al., 2014). Experimental research corroborates the hypothesised link between a stressful social evaluation and a proinflammatory immune response (Slavich and Irwin, 2014; Muscatell and Eisenberger, 2012; Powell et al., 2013; Knight and Mehta, 2017; Muscatell et al., 2016). In real-world settings, observational studies have accumulated evidence for the inverse association between markers of systemic inflammation, particularly high-sensitivity C-reactive protein (hs-CRP) and SEP. Individuals in disadvantaged SEPs consistently show a higher concentration of circulating hs-CRP even after adjusting for mediating behavioural factors (Vineis et al., 2020; Berger et al., 2019; Muscatell et al., 2018; Liu et al., 2017a; Castagné et al., 2016a, 2016b). Chronically elevated levels of hs-CRP, in turn, have repeatedly demonstrated their involvement and predictive power in the onset of cardiovascular disease, depression, and other leading causes of disability and mortality globally (Slavich and Irwin, 2014; Furman et al., 2019; The Emerging Risk Factors Collaboration, 2010; Liu et al., 2017b). This makes hs-CRP a theoretically suitable and practically relevant health outcome for studying psychosocial explanations for health inequalities.

Investigating how status inequality as a contextual-level characteristic relates to health outcomes via psychosocial mechanisms, most research relies on measurements of income inequality to describe the extent of status inequality in societies – most prominently the Gini coefficient (Wilkinson and Pickett, 2018; Pickett and Wilkinson, 2015; Layte et al., 2019; Kondo et al., 2009; Hu et al., 2015). This operationalisation of status inequality, despite income's convenient handling as a continuous variable and some empirical support in public health research, earned criticism for lacking theoretical grounding in social stratification analysis (Goldthorpe, 2010; Paskov and Richards, 2021; Lynch and Smith, 2002). Using income inequality as an indicator of status inequality assumes that income and social status are synonymous or at least highly correlated in the context under study. In contrast, it has been shown that, while income and class are strongly associated, the association between income and status is far weaker (Goldthorpe, 2010). Although differences in income give an account of economic advantage or disadvantage, they often hold little information about status inequality (Goldthorpe, 2010). Moreover, as data on income inequality are not readily available on smaller spatial resolutions in many countries, analyses implicitly assume that the effects of contextual-level status inequality on individual-level outcomes operate on a country or state level. Contrarily, in the neighbourhood effects literature, 'social-interactive' mechanisms are considered to transpire on smaller, rather than larger spatial levels (Galster et al., 2012; Patel et al., 2018). Research on psychosocial causes of health inequalities emphasises that one's SEP has a subjective meaning that arises from comparison with others. Socioeconomic position of others in an individual's local context and the local social environment may be one of the backgrounds against which one's own status is assessed. After all, in a small enough area, residents will, based on visual cues and social connections, have some assessment of other residents' SEP and thus the local social hierarchy (Kraus et al., 2013). This is also in line with research showing that people are able to perceive socioeconomic characteristics of others with only limited information available (Kraus et al., 2013, 2017) and that local social information (especially among disadvantaged individuals) tends to be more relevant for social comparisons than abstract general information (Zell and Alicke, 2010; Norton, 2013; Zell and Lesick, 2021).

In Fig. 1, we illustrate this hypothesised context-dependency of SEP. The upper left panel (Panel 1) suggests that individuals self-assess their social status based on the complete status distribution in their respective society – an abstract social entity – and therefore obtain a 'correct' perception of their social rank unbiased by their local context (no boxes around same SEP groups). In this scenario, the effect of observable indicators of SEP on health outcomes via psychosocial pathways are congruent with the effects of subjective social status on health outcomes. In the extreme case that only local status distributions matter as reference frames for an individual's SEP (Panel 2), the psychosocial effects of SEP will depend on a more proximately perceived status distribution. Despite having identical SEPs, individuals in Context A perceive their social status to be lower than individuals in Context B or C because there are more individuals with higher SEP than their own within their local context. Conversely, it may also be the case that the status of a context itself, for example a neighbourhood, becomes the relevant unit by which individuals self-asses their status (Panel 3). If this applies, all individuals in Context A will perceive their status to be higher than individuals in the same SEPs within Context B and C. More realistically, all of these – social comparisons within an abstract social entity (abstract comparison), comparisons in a more tangible local context (intra-context comparison), and status comparisons between own local context and other local contexts (inter-context comparison) – are potential sources for stressful social experiences (Panel 4). Which mechanisms apply can be situational and may depend on individuals' own SEP (Gerber et al., 2018). To our knowledge, only two studies have investigated whether status inequality (measured by income inequality) moderates the strength of association between indicators of SEP and hs-CRP (Layte et al., 2019; Clark et al., 2012). The results of both of these studies suggest the existence of this effect moderation on a country-level in Europe and state-level in the US.

1.2. Social cohesion as possible explanation

Many definitions of social cohesion exist. A recent literature review condensed it to an essentialist definition: social cohesion is a gradual, "*descriptive attribute of a collective*" and a cohesive environment *"is characterized by close social relations, pronounced emotional connectedness to the social entity, and a strong orientation towards the common good."* (Schiefer and Noll, 2017) Low social cohesion has often been named as an explanation for why contextual-level status inequality (mostly measured by income inequality) affects individual-level health outcomes through psychosocial pathways. Without detailed specification of this mediation hypothesis, it is often stated that status inequality "increases the social distances between people" and decreases trust indicated by lower civic participation in more unequal countries (Pickett and Wilkinson, 2015; Wilkinson and Pickett, 2017). Furthermore, strong social cohesion is repeatedly hypothesised to buffer and reduce stress, foster supportive relationships, protect from loneliness, reduce social

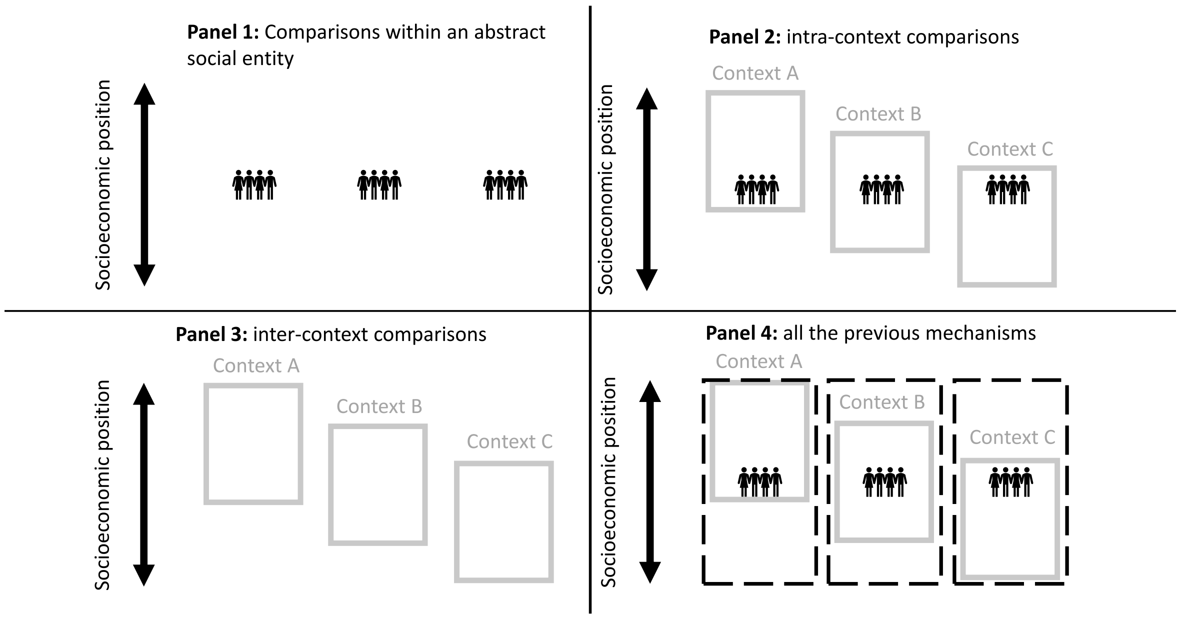

Fig. 1. Visualising context-dependency of socioeconomic position through social comparison: Panel 1) comparison within an abstract social entity; Panel 2) intra-context comparisons within local contexts; Panel 3) inter-context comparisons between local contexts; Panel 4) all the before-mentioned simultaneously (lower right panel).

inequalities, enhance access to resources and opportunities, promote mental-wellbeing, and increase the social transmission of health behaviours (Oberndorfer et al., 2022). It may also facilitate collective action, leading to better neighbourhood conditions, improved health outcomes and resilience (Oberndorfer et al., 2022).

Thus, "psychosocial theory" invokes the idea that high social cohesion alleviates potentially stressful social comparisons as the "social distance" between the SEPs is narrower. In contrast, social comparison theory is more in line with the prediction that under high social cohesion local information becomes more important as people have closer social relations with each other (Schiefer and Noll, 2017) and therefore more tangible and accurate targets for comparisons. Because the dominant direction of social comparisons is upward (comparing with people performing better in the focal trait) and the response contrastive (away from the comparison target) (Gerber et al., 2018), high social cohesion could also intensify local status comparisons. While we found no studies that also considered the potential mediating effects of social cohesion, a few studies have estimated the association between individual-level perceived social cohesion (Neergheen et al., 2019; Holmes and Marcelli, 2012; Nguyen et al., 2022) or contextual-level social cohesion (Nazmi et al., 2010) and hs-CRP with mixed results.

Studies aiming to test the full theoretical pathway visualised in Fig. 2 require representative data on individual-level outcomes linkable to information on contextual-level status inequality as well as the level of social cohesion included individuals are experiencing. The West of Scotland Twenty-07 study meets these necessary requirements and thus offers a rare opportunity to test the mediated moderation described above. Using Scottish and English census data, we were able to create measurements of status inequality within small-area-level residential contexts of study participants. Following theoretical propositions of geography and psychology, we believe this approach is better equipped to disentangle potential psychosocial from neo-material causes of variation in health inequalities than using income inequality as an explanation of variation in cross-national or state-level analyses.

To summarise, this study aims to complement previous literature by investigating if, and to what extent, status inequality within small-area-level residential contexts of individuals moderates the association between SEP and concentration of circulating high-sensitivity C-reactive protein (hs-CRP) and whether this moderation is mediated by contextual-level social cohesion.

2. Methods

2.1. Data

We analysed data collected during the fifth wave of the West of Scotland Twenty-07 Study (Benzeval et al., 2009). This study was set up in 1986 and followed three cohorts 20 years of age apart from each other for 20 years. Data were collected in 1986, 1990/92, 1995/97, 2000–2004, and 2007/08. The achieved sample at the first wave

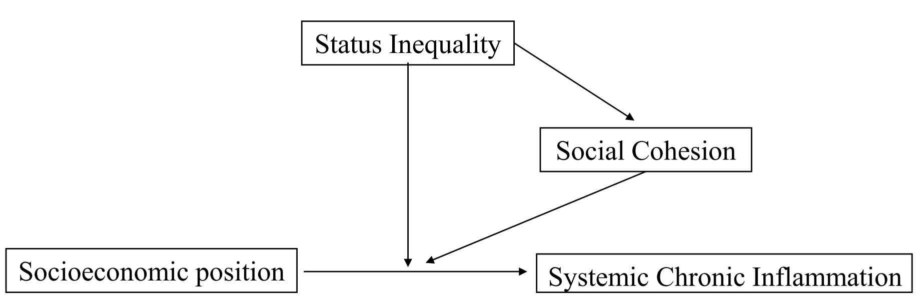

Fig. 2. Visually summarising the theoretical propositions proposed in the literature: contextual-level status inequality moderates the association between individual-level socioeconomic position and systemic chronic inflammation because status inequality "erodes" social cohesion.

consisted of 4510 study participants randomly selected from 52 postcode sectors in the Central Clydeside Conurbation, West of Scotland. At the first wave in 1986, the sample consisted of 1515 participants in the 1970s cohort, 1444 in the 1950s cohort, and 1551 in the 1930s cohort. At wave 5, the sample reduced to 942 (1970s cohort), 999 (1950s cohort), and 663 (1930s cohort) participants living in 449 unique postcode sectors with an average of 5.4 (s.d.: 9.13) respondents per unit. This increase in the number of spatial units included resulted from study participants moving between 1986 and 2007. Drop-out was associated with being male, occupation categorised as 'manual', and reporting poor health at wave 1. This association was strongest among the 1930s cohort and drop-out in this cohort was mainly caused by mortality as about 37% had died by 2007/08 (Robertson et al., 2014).

High-sensitivity CRP was measured in 86% of the wave 5 sample. Of the original wave 1 sample, 49% had their hs-CRP measured at wave 5. Confounding due to non-random survey drop-out was mitigated by inverse probability weights (Seaman and Benzeval, 2011). Further details of the study design are described elsewhere (Benzeval et al., 2009).

To measure status inequality within residential contexts of study participants, we used openly accessible Scottish (https://www.scotlandscensus.gov.uk/documents/2001-census-data-all-areas/, last access: December 05, 2022) and English census (https://casweb.ukdataservice.ac.uk/step0.cfm, last access: December 05, 2022) data collected in 2001. English data was used for study participants who lived in England at the last wave of data collection.

2.2. Variables

2.2.1. High-sensitivity C-reactive protein

The outcome variable of interest was circulating hs-CRP measured in mg/L. Blood samples were taken by trained nurses during home visits for wave 5 of data collection in 2007/08. In total, hs-CRP was measured for 2229 study participants (788 in 1970s cohort, 881 in 1950s cohort, 560 in 1930s cohort). High-sensitivity CRP was used as a continuous variable as previous studies have shown linear associations of hs-CRP concentration with risk of clinical endpoints like coronary heart disease, ischaemic stroke, and non-vascular deaths instead of a step-function (The Emerging Risk Factors Collaboration, 2010; Ridker, 2016). According to CRP's clinical interpretation of cardiovascular risk, values below 1 mg/L indicate low systemic inflammatory status and therefore low risk, values between 1 and 3 mg/L are interpreted as average or moderate, and more than 3 mg/L up to 10 mg/L as high risk. Values of 10 mg/L or higher may indicate acute phase immune response and participants with these values were therefore excluded from our analysis (Ridker, 2016).

2.2.2. Socioeconomic position (SEP)

SEP of study participants was measured by highest household current or most recent occupational class according to the Registrar General's Classification of Occupations (OPSC, 1980). This classification comprises six categories: professional, intermediate, skilled non-manual, skilled manual, partly skilled, and unskilled. As this categorisation is not strictly (linear) hierarchical (Shaw et al., 2007), this variable was treated as categorical in all models. Many indicators of SEP could be used for our analyses, however, occupational group indicators (particularly in the UK) may better reflect social standing and prestige (Shaw et al., 2007) and therefore are closer to the psychosocial processes we are interested in. Due to data sparsity, we used a collapsed version of our SEP variable wherein we grouped the following together: professional and intermediate, skilled non-manual and skilled manual, partly skilled and unskilled to estimate cross-level interactions.

Our data also contains information on participants' self-perceived social status (1–10; see suppl. p.2 for details) which we used in complementary analysis to explore the theoretical plausibility of psychosocial explanations.

2.2.3. Status inequality

We created a measurement of status inequality using Scottish and English census data collected in 2001. These data contain population-wide information on the proportion of the residential population aged 16–74 in each SEP (based on a household reference person) on multiple spatial levels. For census data collected in 2001, National Statistics Socio-economic classification (NS-SEC) was used to classify occupations into 8 categories (higher managerial and professional occupations, lower managerial and professional occupations, intermediate occupations, small employers and own account workers, lower supervisory and technical occupations, semi-routine occupations, routine occupations, never worked and long-term unemployed) (Rose et al., 2005). As the 8 NS-SEC categories are not intended to form a hierarchical classification, we further grouped NS-SEC categories into 3 groups which are more hierarchically related (managerial and professional occupations, intermediate occupations, routine and manual occupations) (Shaw et al., 2007).

A conceptual demonstration of how our approach captures extent and direction of status inequality is presented in Fig. 3 wherein we use Scottish and English census data (2001) for postcode sectors (Scotland) and middle layer super output areas (MSOAs; England) ($n = 506$) in which study participants lived at the fifth wave of the Twenty-07 study. A detailed explanation of our method is provided in our supplementary material p.4. We simultaneously analysed Scottish postcode sectors and English MSOAs as participants have moved to England during the Twenty-07 study and because postcode sectors and MSOAs are comparable in population size (see suppl. p.4). Values smaller than 0 indicate a status distribution within a given spatial unit that is skewed towards more advantaged SEPs ('top-heavy' status distribution) whereas values greater than 0 indicate a status distribution that is skewed towards disadvantaged SEPs ('bottom-heavy' distribution). The farther away from 0, the greater is the extent of status inequality within an area. The blue-coloured distribution (upper left panel) in Fig. 3 shows the mean proportion of the residential population aged 16–74 in each group for the 33.33% top-heaviest of the included postcode sectors/MSOAs (classified by our status inequality measurement) and the respectively estimated coefficient of status inequality (−0.15) for this distribution. The red-coloured distribution (lower left panel) in Fig. 3 shows the 33.33% bottom-heaviest of the included postcode sectors/MSOAs and thus the respective status inequality coefficient (0.15) for their mean distribution is positive. The yellow-coloured distribution (upper right panel) shows the average proportion of residents in each of the three NS-SEC categories for the middle third of the included postcode sectors/MSOAs and thus presents a roughly equal socioeconomic mix of residents (status inequality coefficient = 0.02).

2.2.4. Social cohesion

The Twenty-07 study asked respondents about the level of social cohesion in their residential area. The instrument used at wave 5 was proposed by Sampson et al. (1997) and has been shown to consistently capture the contextual variation of social cohesion (Oberndorfer et al., 2022). Participants were given 5 statements: "this is a close-knit neighbourhood", "people around here are willing to help their neighbours", "people in this neighbourhood generally don't get along with each other", "people in this neighbourhood do not share the same values", "people in this neighbourhood can be trusted". Possible responses ranged from "strongly agree" (1) to "strongly disagree" (5). We applied ecometric modelling to estimate the level of social cohesion for included spatial units and the intracluster correlation coefficient and contextual-level reliability of our measurements using data from all participants in wave 5. In brief, ecometrics – "the science of assessing ecological settings" (Raudenbush and Sampson, 1999) – conceives respondents as informants of their local context and uses multilevel modelling to arrive at a contextual-level measurement which is represented by the context-specific deviation from the grand mean of a contextual-level characteristic. Our approach is described in the

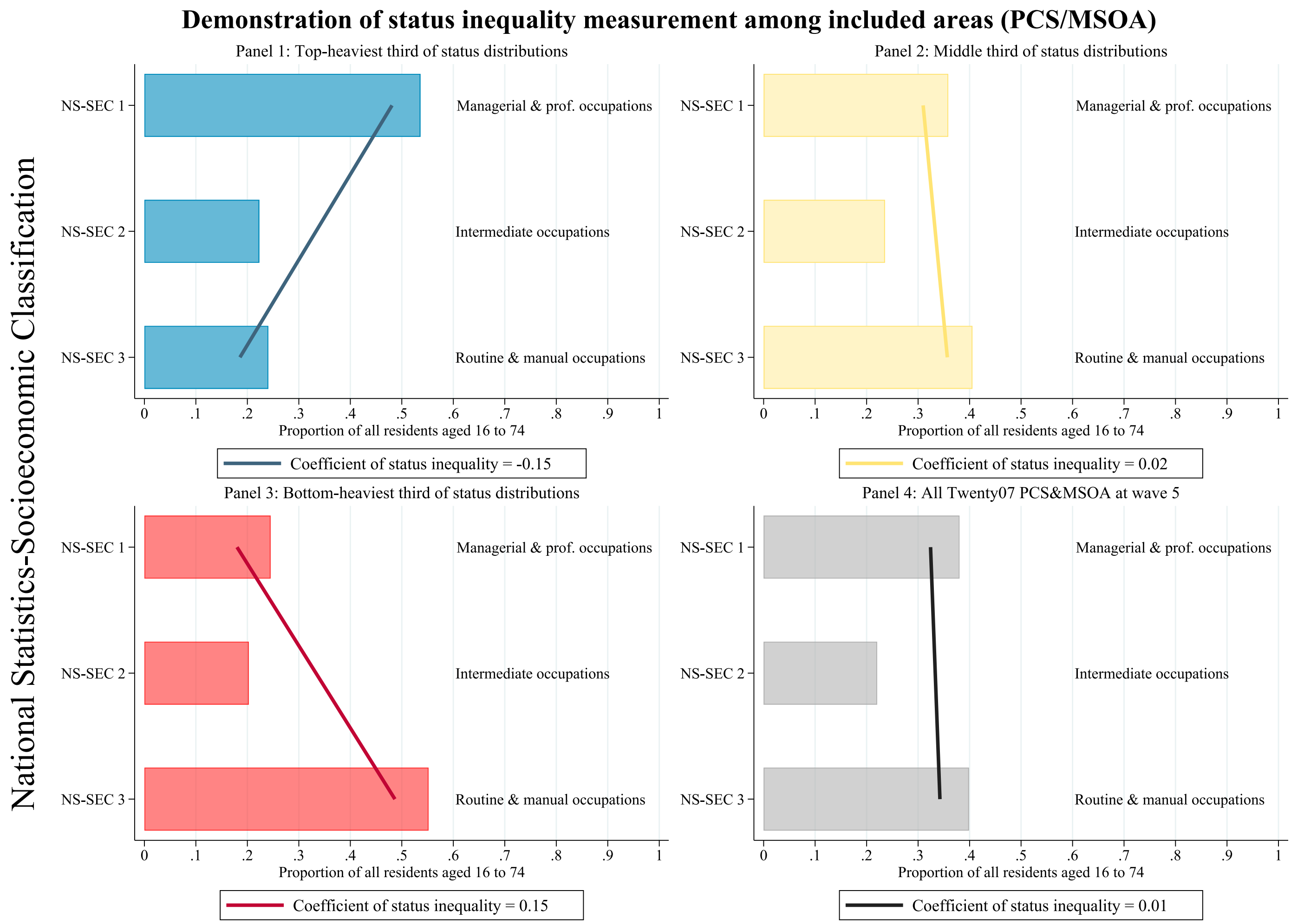

Fig. 3. Status distribution (1 = managerial and professional occupations; 2 = intermediate occupations; 3 = routine and manual occupations) and respective status inequality measure for 506 postcode sectors (Scotland) and middle super layer output areas (England) (2001 census). Upper left panel (blue) shows the mean status distribution in the top-heaviest third of included areas. Lower left panel (red) shows the bottom-heaviest third of included areas. Upper right panel (yellow) shows the mean status distribution among the middle third of included areas according to their estimated status inequality. Bottom right panel shows mean proportions across all included postcode sectors/MSOAs. Only areas in which Twenty-07 study participants lived during the last interview were included.

supplementary material (p.4). For recent introductions to ecometrics, see Leyland and Groenewegen, 2020 and Oberndorfer et al., 2022, and Oberndorfer et al., 2022 for a methodological review of social cohesion measurements using ecometrics. Ecometric measurement models yield a contextual-level estimate of social cohesion for all spatial units wherein at least one response to a statement was non-missing. In the absence of strong theory on which individual level characteristics bias perception of social cohesion and which act on perception by affecting the true level of social cohesion within an area, we opt to estimate unadjusted measurement models (Oberndorfer et al., 2022).

2.2.5. Statistical analysis

We present descriptive statistics for all individual and contextual-level variables of interest in Table 1 and Table S1. A flow chart (Fig. 4) describes the sample selection process. We included all individuals with complete information on outcomes and covariates of interest and mitigated loss to follow-up by applying inverse probability weights (Seaman and Benzeval, 2011). Associations between missingness of hs-CRP data and SEP, status inequality, or social cohesion (separately) were estimated by logistic regression to investigate if non-random missingness in our outcome data is potentially biasing our estimates.

For our main analysis, we chose postcode sectors (Scotland) and MSOAs (England) as our spatial level. Previous research has indicated their population size achieving highest validity (ICCs) for contextual-level social cohesion measurements (Oberndorfer et al., 2022) and we expect measurement reliability for social cohesion to be highest on this spatial level in our data. Linear multilevel models were estimated by maximum likelihood estimation with clustered standard errors.

The regression analysis was structured by three sequences.

Model 1. Individual-level socioeconomic inequalities in hs-CRP

First, our aim was to estimate differences in mean hs-CRP concentrations by current or most recent SEP of study participants by linear multilevel models wherein respondents are nested within postcode sectors/MSOAs. In our first and most parsimonious model specification, we included gender and age of participants in our models as we expect these variables to affect SEP as well as hs-CRP concentration (Model 1).

Model 2. – Cross-level moderation by status inequality

In the second stage, we tested whether the association between individual-level SEP and hs-CRP is dependent on the extent and direction of status inequality within a respondent's residential area. To this end, we included cross-level interaction terms between SEP and status inequality in Model 2. We did not impose a functional form on our interaction term, as the literature proposes contradicting hypotheses: positive externalities (e.g., benefitting from higher investments in

Table 1
Presentation of results.

Results	Text	Tables	Visualisations
Sample selection	p14		Fig. 4 (p16)
Participants' characteristics	p14	Table 2 (p17)	
Contextual units' characteristics	suppl. p3-4	Table S1 (suppl. p3)	Fig. 3 (p10)
Regression analysis			
Model 1: Individual-level socioeconomic inequalities in hs-CRP	p18	Table S2 (suppl. p6)	Fig. S1 (suppl. p8)
Model 2: Cross-level moderation by status inequality	p18-19	Table S2 (suppl. p6), Table S3 (suppl. p7)	Fig. 5 (p20), Fig. S5 (suppl. p12)
Model 3.1: Association between contextual-level social cohesion and status inequality	p19		
Model 3.2: Three-way interactions between SEP, status inequality, and social cohesion	p20	Table S2 (suppl. p6)	Fig. 6 (p21), Fig. S6 (suppl. p13), Fig. S7 (suppl. p14)
Sensitivity & complementary analysis			
Reliability of social cohesion measurement	p19	Table S1 (suppl. p3)	Fig. S2 (suppl. p9), Fig. S3 (suppl. p10), Fig. S4 (suppl. p11)
Sensitivity to spatial level of analysis	p20-21		Fig. S5 (suppl. p12), Fig. S6 (suppl. p13), Fig. S7 (suppl. p14), Fig. S8 (suppl. p15), Fig. S9 (suppl. p16), Fig. S10 (suppl. p17)
Subjective social status	p20	Table 2 (p17)	Fig. S11 (suppl. p18), Fig. S12 (suppl. p19)

infrastructure of an area) of living in a 'top-heavy' distribution for people in disadvantaged SEPs (Galster et al., 2012); the negative effect of intensified status distinction and stressful social comparisons across all SEPs (Wilkinson and Pickett, 2010); competition is strongest among close equals (Wilkinson and Pickett, 2006). Therefore, we categorised status inequality along terciles and estimated semi-parametric interaction terms.

Additionally, we tested linear gradients by estimating p-values for trend for estimates of mean hs-CRP derived from Model 2 and by estimating a linear slope for occupational classes or status inequality on hs-CRP in stratified data.

Model 3.1. and 3.2 - Three-way interactions between SEP, status inequality, and social cohesion

Third, we introduced the second contextual-level variable of interest which is hypothesised to mediate the effect moderation tested in the second stage: social cohesion. Before testing the entire pathway, we tested whether mediation is plausible by regressing our contextual-level measure of social cohesion on our measure of status inequality in an ecological regression model. Contrary to measures of income inequality, our measure of status inequality not only captures extent of inequality, but also its direction. Therefore, we estimated this relationship imposing a linear functional form and using a semi-parametric model specification (Model 3.1). The dynamics of this relationship are contested and rarely explicitly specified. Our data (status inequality measured in 2001 and social cohesion measured in 2007) imply the vaguely suggested temporal order. We proceeded by extending Model 2 by including three-way interactions between SEP, status inequality, and social cohesion, as well as their respective two-way interactions and main effects (Model 3.2). Mediated moderation was investigated by the estimated effect of status inequality on social cohesion (Model 3.1) and a joint test of all estimated coefficients for the four three-way interactions (Model 3.2). Finally, parameter estimates for the two-way interactions between SEP and status inequality in Model 3.2 were compared against estimates of Model 2 to assess whether moderation is explained by its effect on social cohesion.

2.2.6. *Sensitivity & complementary analysis*

While smaller areas are favoured in geographical and psychological arguments about social-interactive mechanisms like status comparison, current theory lacks a distinction between small geographies with population sizes below 5000 residents (Patel et al., 2018; Petrović et al., 2020, 2022). In sensitivity analyses, we therefore explored how our estimates of context-dependencies change as we alter the spatial level of our analysis.To this end, we estimated our status inequality and social cohesion measurements on three additional spatial levels: output area level (Scotland and England), data zone (Scotland)/lower layer super output area (LSOA, England), and consistent areas through time (CATT, Scotland)/LSOA (ordered in increasing average population size). Combination of Scottish and English geographies are based on similarities in average population size within units which are reported in Table S1. All regression models described above were then re-estimated using these spatial levels instead of postcode sectors/MSOAs.

In another sensitivity analysis, we restricted our sample to postcode sectors with more than 1 participant to increase reliability of our contextual level social cohesion measurement. Additionally, we complemented our findings by estimating i) whether subjective social status shows a linear association with hs-CRP and ii) whether participants in the same SEP groups self-assess their social status differently depending on the status inequality in their postcode sector of residence (see suppl. p.2). If experimental research on inflammatory markers and social evaluation (Segerstrom and Miller, 2004; Muscatell et al., 2016) is confirmed by these observational data, we expect hs-CRP stronger associated with subjective social status than SEP based on observable socioeconomic indicators. Second, if the meaning of an SEP indicator depends on the social environment due to social comparison (Gerber et al., 2018), we should expect participants in the same SEP group to perceive their status differently depending on their local status distribution.

3. Results

To aid orientation, Table 1 shows where our results are presented in text, tables, and figures throughout the manuscript and the supplementary material.

3.1. *Characteristics of study participants and spatial units*

The analysed sample contained 1977 participants after excluding participants with missing information on hs-CRP (n = 375) or hs-CRP concentration of 10 mg/L or higher (n = 180), SEP (n = 1), status inequality (n = 10), and social cohesion (n = 61) in their postcode sector of residence. The 375 study participants excluded due to missing data for hs-CRP did not systematically differ from the estimation sample regarding their occupational group, their residential status distribution, and social cohesion in their postcode sector of residence..

The sample selection process is presented in detail in Fig. 4. In Table 2, we present a description of unweighted individual-level characteristics of included study participants as well as characteristics after applying weights constructed to mitigate non-random survey drop out (Seaman and Benzeval, 2011). The unweighted mean hs-CRP concentration among participants (2.523 [95%CI: 2.427; 2.619]) was slightly below the mean in the weighted sample (2.645 [95%CI: 2.500; 2.791]). Most participants in the analysed sample were in intermediate occupations (unweighted: 41.58%; weighted: 38.97%) which include clerical, administrative, sales, service, technical, auxiliary, and engineering occupations. Postcodes of 10 participant's residential location were not identifiable and could therefore not be matched to higher level spatial units..

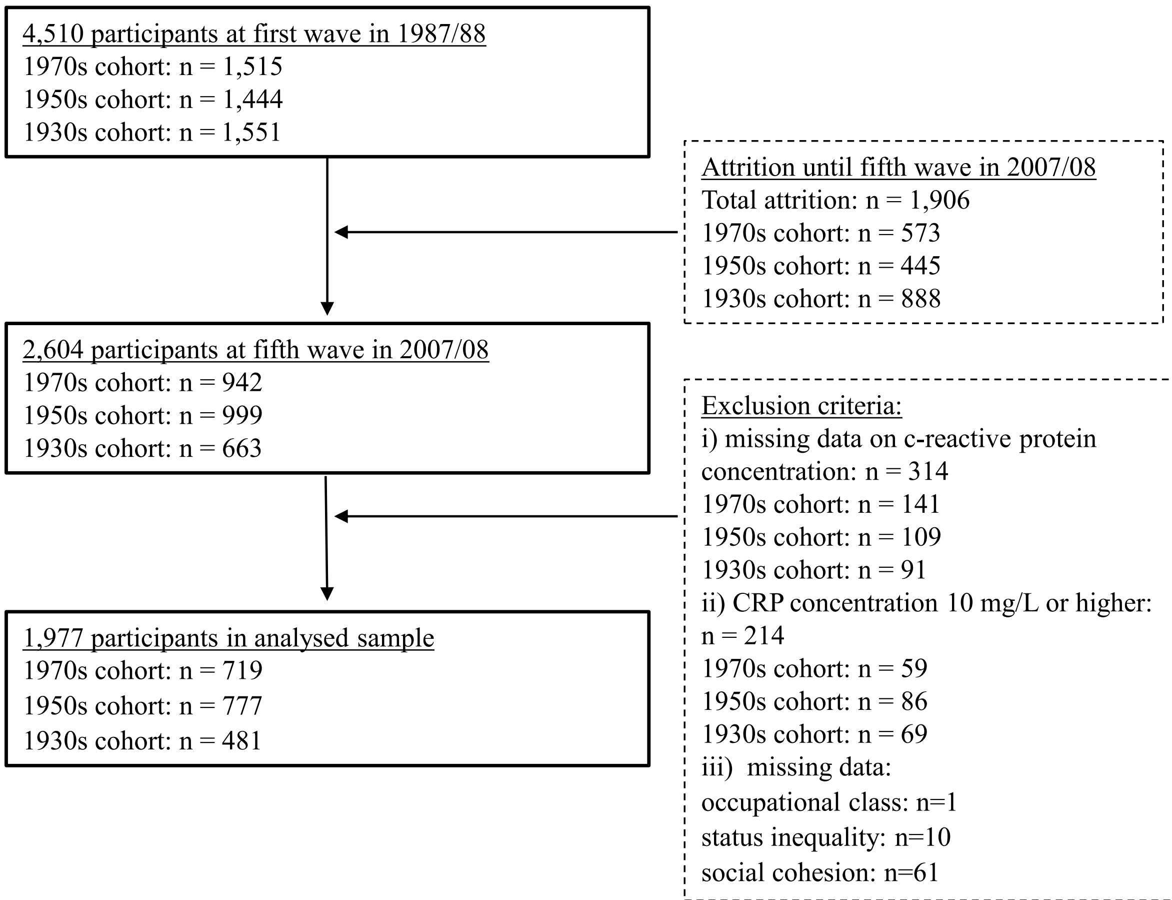

Fig. 4. Sample selection process (West of Scotland Twenty07 study).

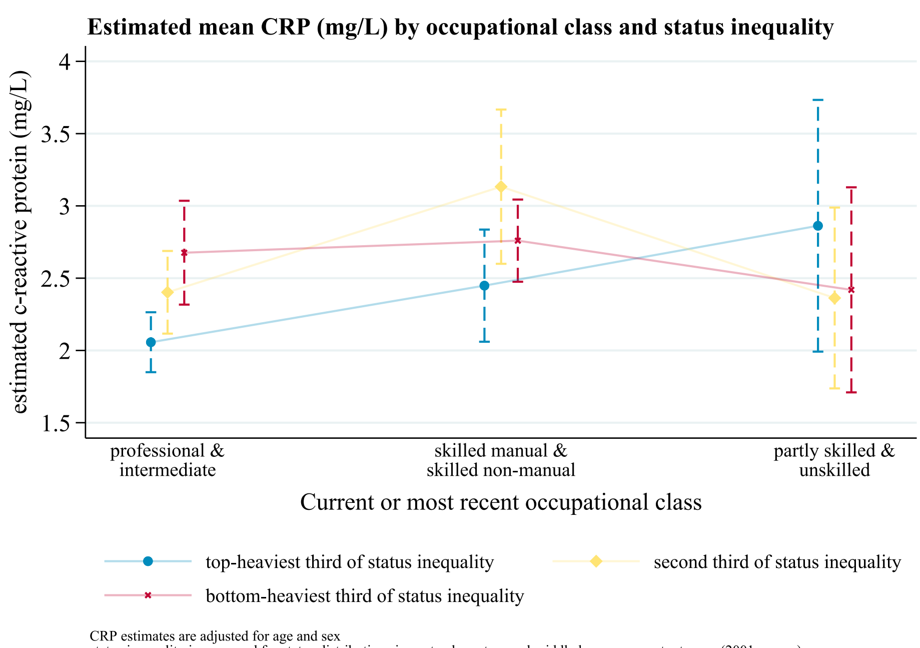

Fig. 5. Estimated differences in mean high-sensitivity C-reactive protein (mg/L) by occupational group and status inequality derived from Model 2 (participants: n = 1977; postcode sectors/MSOAs: n = 449).

3.2. Regression results

Table S2 (suppl. p.5) and Fig. S1 (suppl. p.7), Fig. 5, and Fig. 6 present results of our regression analysis. The ICC for our outcome hs-CRP was 0.182 [95%CI: 0.122; 0.264] in an unconditional multilevel model with random intercept for postcode sectors/MSOAs.

Table 2
Individual-level descriptive characteristics of unweighted and weighted sample.

	Unweighted Mean (std. dev.) Median (IQR) n (%)	Weighted Mean (linearized std. err.) Median (IQR) n (%)
Sample size[1]	*n* = *1977*	*n* = *3345*
High-sensitivity C-reactive protein (mg/L)	2.523 (2.178)	2.645 (0.742)
Socioeconomic position[2]		
I professional	n = 257 (13.00%)	n = 356 (10.6%)
II intermediate	n = 822 (41.58%)	n = 1303 (38.97%)
III skilled non-manual	n = 397 (20.08%)	n = 684 (20.45%)
III skilled manual	n = 273 (13.81%)	n = 510 (15.24%)
IV partly skilled	n = 173 (8.75%)	n = 394 (11.78%)
V unskilled	n = 55 (2.78%)	n = 98 (2.93%)
Status distribution[3]		
top-heavy	n = 665 (33.64%)	n = 1017 (30.40%)
equal	n = 656 (33.18%)	n = 1124 (33.61%)
bottom-heavy	n = 656 (33.18%)	n = 1204 (35.99%)
Age	54.33 (15.26)	54.18 (0.493)
Female	n = 1054 (53.31%)	n = 1780 (53.2%)
Smoker		
never smoker	n = 894 (45.22%)	n = 1428 (42.69%)
former smoker	n = 616 (31.16%)	n = 1020 (30.48%)
current smoker	n = 462 (23.37%)	n = 891 (26.64%)
missing	n = 5 (0.25%)	n = 6 (0.19%)
Vigorous physical activity (0–7)[4]	1 (IQR: 0–4)	1 (IQR: 0–3)
missing	0	0
Alcohol consumption[5]		
never	n = 106 (5.36%)	n = 193 (5.76%)
formerly	n = 112 (5.67%)	n = 240 (7.16%)
currently	n = 1754 (88.72%)	n = 2906 (86.88%)
Missing	n = 5 (0.25%)	n = 6 (0.19%)
Subjective Status (1–10)		
In relation to others in Britain[6]	6.067 (1.646)	5.952 (0.049)
missing	n = 50 (2.5%)	
In relation to others in local area[6]	6.653 (1.664)	6.560 (0.048)
missing	n = 47 (2.4%)	

[1] After exclusion of participants with missing hs-CRP or hs-CRP ≥10 mg/L or missing data for SEP, status inequality, or social cohesion.
[2] Based on current or most recent occupation.
[3] Thirds are based on all postcode sectors/MSOAs in which participants lived.
[4] "In an average week, how many days do you spend at least 20 continuous minutes doing vigorous physical exercise, enough to make you sweaty and out of breath" (0–7).
[5] "Ever drink alcohol, even if it is just occasionally".
[6] "At the top of the ladder are the people who are best off – those with the most money, most education, and best jobs" Participants were asked to place themselves on a ladder with 10 rungs. On page 3 to 4 in our supplementary material (Table S1), we describe characteristics of included spatial units.

Results of Model 1 (individual-level socioeconomic inequalities in hs-CRP)

As visualised in Fig. S1, hs-CRP tended to be lower in more advantaged occupational groups. A linear gradient in hs-CRP along this indicator of SEP, however, is less compatible with our data. In Fig. S1, we have shown age and gender adjusted mean hs-CRP concentrations for each occupational group (left panel) before reducing this indicator to 3 categories (right panel).

Results of Model 2 (cross-level moderation by status inequality)

In Fig. 5, we present estimated average hs-CRP by occupational group and status inequality derived from Model 2 (Table S2). We observed that socioeconomic inequalities in average hs-CRP varied by status distribution in which participants lived (Fig. 5, Table S3). For participants living in 'top-heavy' status distributions, the estimated difference in hs-CRP between participants in partly skilled & unskilled occupations (referred to as disadvantaged SEPs) and in professional & intermediate occupations (advantaged SEPs) was 0.806 mg/L ($p = 0.063$, [95%CI: −0.0443; 1.656]). In equal and 'bottom-heavy' distributions, the difference in estimated mean hs-CRP between disadvantaged and advantaged SEP was −0.039 mg/L ($p = 0.898$ [95%CI: −0.644; 0.566]) and −0.257 mg/L ($p = 0.568$ [95%CI: −1.139; 0.625]) respectively. Two other comparisons were of theoretical interest: among participants in advantaged SEPs, those living in 'bottom-heavy' status distributions have shown a 0.619 mg/L ($p = 0.003$ [95%CI: 0.210; 1.029]) higher estimated hs-CRP than those living in 'top-heavy' distributions. Conversely, participants in disadvantaged SEPs living in 'bottom-heavy' status distribution had a −0.443 mg/L ($p = 0.445$ [95% CI: −1.580; 0.693]) lower hs-CRP than those living in 'top-heavy' status distributions with high uncertainty around these estimates due to low cell counts.

In Table S3 (Suppl. p.7), we present more formal tests of linear socioeconomic gradients in systemic chronic inflammation in our data. A linear gradient in hs-CRP was supported along occupational groups in 'top-heavy' distributions, but not in equal and 'bottom-heavy' status distributions. Within the same occupational groups, a linear gradient along status inequality was only supported for 'top-heavy' status distributions.

Results of Model 3.1 and 3.2 (three-way interactions between SEP, status inequality, and social cohesion)

The results of Model 3.1 (not shown) indicate that there is an inverse linear relationship ($\beta = -0.146$, $p < 0.001$ [95%CI: −0.205; −0.087]) between contextual-level social cohesion in a postcode sector/MSOA and its status inequality. This linear association was observed at all spatial levels (results not shown). Results of estimating Model 3.2 wherein social cohesion was added are shown in Table S2 and visualised in Fig. 6. The joint statistical test of our 4 three-way interactions in Model 3 indicated the presence of mediated moderation in our data (chi (Wilkinson and Pickett, 2018) = 16.57, $p = 0.002$). To help interpretation, we again plotted estimated mean hs-CRP by occupational group and status inequality but fixed the level of contextual-level social cohesion to i) the first decile (Fig. 6; upper left panel), ii) to the bottom decile (Fig. 6; upper right panel), and iii) to the average level of social cohesion (Fig. 6; bottom left panel). In 'top-heavy' status distributions, where evidence for a socioeconomic gradient in hs-CRP was strongest in Model 2, participants living in postcode sectors/MSOAs with high social cohesion showed a shallower gradient than those living in 'top-heavy' status distributions with average or low social cohesion. In equal and 'bottom-heavy' status distributions, high social cohesion led to an opposite observation: participants in disadvantaged SEPs had the highest hs-CRP concentration in areas with high social cohesion and the lowest in areas with low social cohesion. Note that uncertainty around these estimates was high (Fig. 6). Furthermore, differences within professional & intermediate occupational groups, as well as skilled occupational groups living in different status inequality were smallest in areas with high social cohesion and greatest at low social cohesion. Coefficients estimated for the interaction terms between SEP and status inequality decreased in Model 3 compared to Model 2.

3.3. *Results of sensitivity & complementary analysis*

To increase the reliability of our contextual-level social cohesion measurement, we reduced our sample to participants living in postcode sectors/MSOAs with 2 or more respondents informing the social cohesion measurement. Again, this did not change results significantly (see Figs. S2–S4). Finally, we investigated whether our estimates changed if we alter the spatial level of our analysis. Coefficients of our four two-way interactions estimated by Model 2 were relatively consistent across spatial levels except for the CATTs/LSOA level (Fig. S5). At spatial levels other than postcode sectors/MSOAs, these coefficients were not attenuated in Model 3 (see Fig. S6). Coefficients of our four three-way interactions estimated by Model 3.2 were consistent across all four spatial levels (see Fig. S7). We further display estimated differences in mean hs-CRP by SEP and status inequality for each spatial scale (Figs. S8–S10). Finally, we observed an inverse linear association between subjective

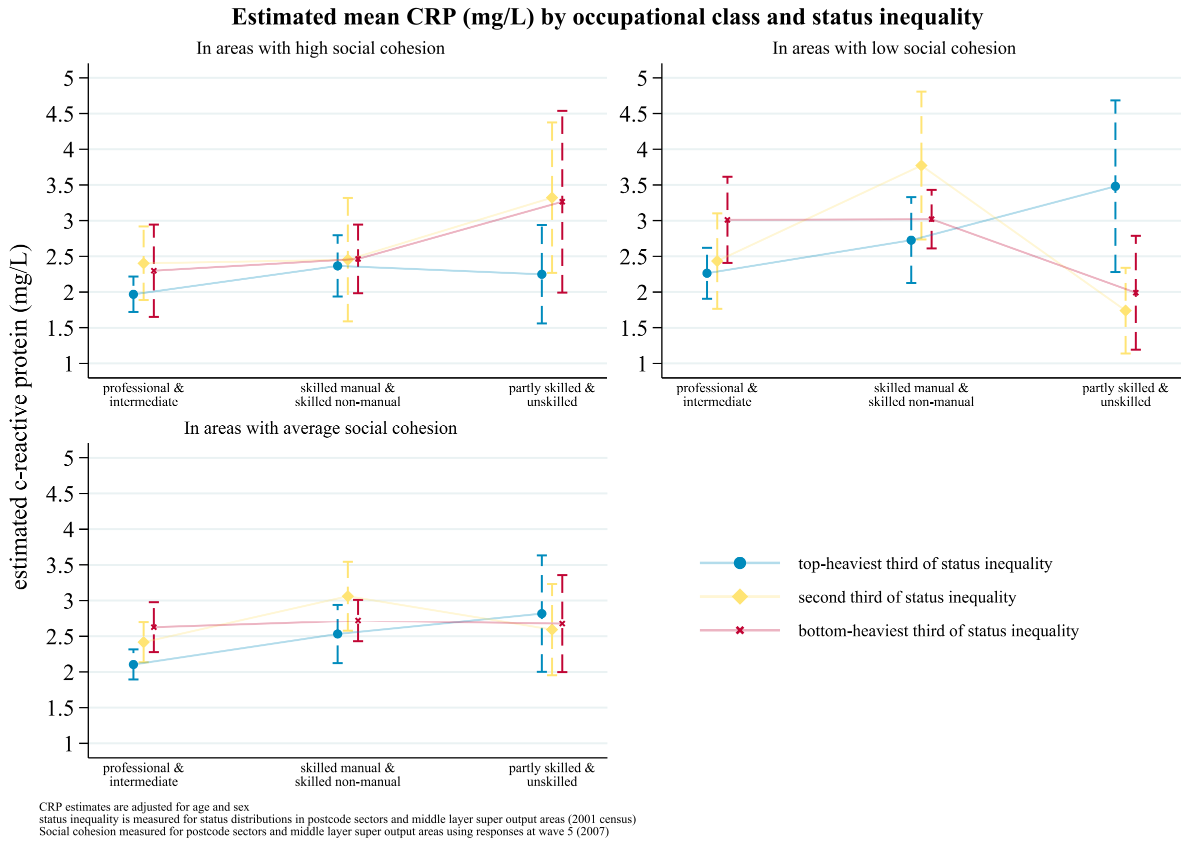

Fig. 6. Estimated differences in mean high-sensitivity C-reactive protein (mg/L) by occupational group and status inequality for postcode sectors/MSOAs with high social cohesion (first decile; left top panel), low social cohesion (last decile; top right panel), and average social cohesion (mean; bottom left panel). Estimates derived from Model 3 (participants: n = 1977; postcode sectors/MSOAs: n = 449).

social status and hs-CRP (Fig. S11). Subjective status self-assessed in relation to "others in Britain" had a stronger association with hs-CRP than social status self-assessed in relation to "others in local area" (Fig. S11). Lastly, we found that participants living in areas with a higher share of residents in advantaged SEPs consistently perceive their own status higher than participants in the same SEPs living in areas with higher share of residents in disadvantaged SEPs (Fig. S12).

4. Discussion

Using data from the West of Scotland Twenty-07 study, we investigated if the well-established association between individual-level socioeconomic position and systemic chronic inflammation (measured by high-sensitivity C-reactive protein) is dependent on the contextual-level status inequality and social cohesion within residential areas of study participants by estimating linear multilevel models with semi-parametric cross-level interactions. Socioeconomic inequalities in hs-CRP concentrations (mg/L) were most pronounced among participants living in 'top-heavy' status distributions: that is, small areas wherein a high proportion of residents are in managerial or professional occupations and a low proportion of residents are in routine or manual occupations. There was less evidence for a socioeconomic gradient in hs-CRP among participants living in areas with a high proportion of residents in routine or manual occupations and a low proportion of residents in managerial or professional occupations ('bottom-heavy' status distribution), or an equal socioeconomic mix of residents. However, the level of social cohesion within an area was asymmetrically associated with this context-dependency between SEP and status inequality. At high levels of social cohesion, the estimated inequalities in hs-CRP among participants living in 'top-heavy' status distributions were substantially lower while they were wider at low social cohesion. For participants living in equal and 'bottom-heavy' status distributions, our estimates indicated that inequalities in hs-CRP were highest among participants living in areas with high social cohesion.

While the operationalisation of status inequality across studies renders comparisons challenging, the specification of our measure allows for an alternative look on how the effect of an individual's SEP on health outcomes depends on contextual-level status inequality. First, we observed that in contexts of high status inequality, socioeconomic inequalities in systemic chronic inflammation are indeed more pronounced. In our study, the estimated difference in mean hs-CRP concentration between disadvantaged and advantaged SEPs in 'top-heavy' status distributions was 0.806 mg/L [95%CI: −0.044; 1.656]. In a multi-cohort study, Layte et al. linked data collected by five different observational studies (n = 18,349) in four European countries to test whether the difference in hs-CRP between individuals (aged 50 to 75) in advantaged and disadvantaged SEPs is dependent on country level income inequality (Layte et al., 2019). They found that differentials in hs-CRP concentrations between disadvantaged and advantaged SEPs were 0.52 mg/L [95% CI: 0.37; 0.68] among study participants residing in the country with the highest income inequality (measured by the Gini coefficient) among the four included European countries (Layte et al., 2019). Clark et al., 2012 tested this moderation on a state level among 24,664 healthy women living in the United States. Their results suggest that healthy female participants with an income below 20,000$ have, on average, a 1.5 mg/L higher hs-CRP concentration than participants with more than 99,999$ in the most unequal 20% of US states (measured by Gini coefficient) whereas this difference was 0.5 mg/L in the least unequal 20% (Clark et al., 2012). The stronger association between health outcomes and income inequality in the US has been found repeatedly (Kondo et al., 2009). Although these studies and ours used different indicators of SEP, different spatial scales, different study populations, and different measurements of contextual level status inequality – and thereby potentially targeted different pathways – all three point to increased inequalities in systemic chronic inflammation along SEP in contexts of higher status inequality. Yet, adopting a geographical lens on the social-interactive mechanisms behind the "status anxiety hypothesis", our results indicate that this effect moderation is asymmetric and the type of status inequality matters. Put differently, contingent on the type of status inequality – top, equal, or 'bottom-heavy' – the socioeconomic gradient in hs-CRP along occupational groups takes different shapes.

To support the interpretation of these differences, we have estimated differences in hs-CRP by smoking status (never vs current: 0.391 [95% CI: 0.008; 0.773], drinking status (never vs current: 0.001 [95%CI: −0.391; 0.393], and frequency of physical exercise (never vs 7 days a week: −0.389 [95%CI: −0.689; −0.089] using linear multilevel models adjusted for age and gender. More details on these variables are given in the suppl. material on p.2. These estimates based on the Twenty-07 data are smaller but consistent with a previous meta-study on common risk factors of CRP and its association with coronary heart disease and mortality (The Emerging Risk Factors Collaboration, 2010). Against the background of these absolute differences, we consider the extent to which differences in hs-CRP between people in advantaged SEPs are associated with contextual-level status inequality sizable despite wide confidence intervals (Fig. 5).

Our sample consists of study participants born in the 1930s, 1950s, and 1970s and thus were in their mid-30s, mid-50s, and mid-70s when hs-CRP data was collected. Based on a previous assessment of socioeconomic inequalities in CRP by age groups using a bigger sample from the UK (Davillas et al., 2017), we expect our sample to cover age groups with the largest inequalities in hs-CRP. As the majority of our analytic sample were in their prime working age, effects of social comparisons based on occupational class are most plausible in this age group.

Although our study design does not allow for causal conclusions, we may speculate about theoretical mechanisms behind our findings.

Our observation that study participants in disadvantaged SEPs living in 'top-heavy' status distributions tend to have the highest levels of hs-CRP concentration is consistent with current social comparison theory. Living in a 'top-heavy' distribution provides ample availability of upward social comparisons for individuals who self-assess their social status unfavourably. A recent meta-analysis indicated that upward comparison is the most frequent mode of comparison in experimental studies, even when individuals feel socially threatend (Gerber et al., 2018). In addition, contrast – a change in one's self-evaluation away from the comparison target – is the dominant reaction to social comparison (Gerber et al., 2018). Together with the observation that local social information (especially among disadvantaged individuals) tends to be more relevant for social comparisons than abstract general information (Zell and Alicke, 2010; Norton, 2013; Zell and Lesick, 2021), it is plausible that this difference in systemic chronic inflammation emerges from living in an environment that facilitates more frequent (active or passive) upward social comparison in combination with a contrastive response.

This explanation competes with the proposition that affluent areas produce positive externalities for residents in disadvantaged SEPs (Galster et al., 2012) given that these externalities are relevant for systemic chronic inflammation. Our results, however, neither fully supported nor fully refuted these competing hypotheses. In areas with high social cohesion, we found no systematic differences in hs-CRP between socioeconomically disadvantaged and advantaged study participants living in 'top-heavy' status distributions (0.078 [95%CI: −0.662; 0.818]; Fig. S8, upper left panel, hollow circle). In contexts of low social cohesion, study participants in disadvantaged SEPs living in 'top-heavy' status distributions had a 1.171 mg/L [95%CI: 0.009; 2.334] higher hs-CRP concentration than participants in advantaged SEPs (Fig. S8, upper right panel, hollow circle). In other words, positive externalities for systemic chronic inflammations produced by a high number of well-off individuals in an area may only transmit to disadvantaged individuals if social cohesion among residents is high. Importantly, our small-area measure of status inequality was created to test psychosocial pathways of health inequalities whereas a thorough empirical evaluation of the 'positive externalities hypothesis' would require an area-level measure that identifies areas which are characterised by variables hypothesised to produce these positive externalities (e.g. public service provision, retail environment, green spaces, etc.). Creating such an area-level measure aimed at identifying the most "advantageous" areas (the opposite of deprivation measures) could be a valuable new avenue for future health inequalities research considering known limitations of deprivation indices (McCartney et al., 2023).

While, on all examined spatial levels, there is a linear association between the level of social cohesion and status inequality – the top-heavier the status distribution, the higher social cohesion – the estimated mediated moderation suggests that high social cohesion within an area does not automatically translate to reduced socioeconomic inequalities in systemic chronic inflammation. In areas with high social cohesion, socioeconomic inequalities in hs-CRP appeared to be wider among participants living in equal and 'bottom-heavy' status distributions than when social cohesion was low. This could be explained by previous research stating that social cohesion and social capital may have a 'dark side' due to, for example, excessive group conformity, high demands to provide support to others, feelings of restricted individual freedom, exclusion of outsiders and inter-group conflict (Portes, 2014; Villalonga-Olives and Kawachi, 2017).

Among study participants in advantaged SEPs, we observed a linear gradient in hs-CRP along status inequality (Table S3). Deriving predictions from the big-fish-little-pond effect theory, individuals are assumed to rank themselves higher if they are in a high status within their local context and therefore have a more positive self-image and higher self-esteem (Zell and Alicke, 2010; Zell and Lesick, 2021; Gerber et al., 2018). Given that social comparison is indeed a mechanism explaining context-dependency in the association between SEP and hs-CRP, our results contradict this assertion as we found hs-CRP to be lower for advantaged SEPs living in 'top-heavy' status distributions than in equal or 'bottom-heavy' status distributions. This suggests that the relevance of spatially located intergroup to intragroup comparisons may be dependent on an individual's SEP and thereby produce the asymmetric interactions we observed. Our dataset allows for relevant complementary analysis: participants in professional or intermediate occupations (advantaged SEPs) self-reported their social status differently dependent on the status distribution in their place of residence and the comparison group. In relation to others in Britain, people in advantaged SEPs rate themselves higher on the ladder if they live in a 'top-heavy' status distribution compared to those living in an equal or 'bottom-heavy' status distribution (Fig. S12). This pattern does not emerge when participants are asked to rate their social position in relation others in their local area. While socioeconomic differences in hs-CRP along occupational groups did not form the common linear gradient in our data when disregarding context-dependency (Fig. S1), we found strong support for a linear gradient in hs-CRP along subjective social status (Fig. S11).

Based on a set of limitations common to studies interested in contextual effects, we caution readers to draw causal conclusions based on our results.

The West of Scotland Twenty-07 study targeted three birth cohorts (1930, 1950, 1970) and sampled its participants from a socioeconomically diverse selection of postcode sectors (Benzeval et al., 2009). While study participants are indeed a representative sample of this area's population compared to 1991 census data (Der, 1998), this sampling strategy restricts external validity of our results. Furthermore, the data analysed were collected 15 years ago. The effect of SEP on systemic chronic inflammation is plausibly not only influenced by the geographical context of an individual but also by their temporal context. Thus, major societal changes since data collection – e.g., the financial crisis and austerity measures – might have changed the associations observed in our data.

The moderating effect of status inequality on the relationship between SEP and hs-CRP is not biased by unmeasured confounding of the moderator-outcome (status inequality-hs-CRP) relationship (VanderWeele, 2015). However, in case unmeasured confounding of the moderator-outcome relationship is present, the interpretation of the estimated moderating effect will not go beyond effect heterogeneity. That is, changing the level of status inequality within the relevant contextual unit will not necessarily lead to a changed strength of conversion from SEP to hs-CRP for the respective population within that contextual unit (causal interaction). Rather, the extent of status inequality within an area at a given point in time is plausibly the result of a myriad of prior socio-spatial processes, some of which are likely causally related to status inequality within areas and the health status of individuals living in these areas. Census data used to measure status inequality in the residential areas of participants were collected in 2001 while hs-CRP and social cohesion data were collected in 2007. As residential composition of urban areas have been shown to remain relatively stable across time (Sampson, 2012), we consider the measurement error caused by this six-year difference between data collection of the moderator and the outcome limited. Further, a causal interpretation of our results would require a plausible temporal order of exposure, moderator, and mediator of the moderator-outcome relationship which was dictated by data availability in this study. As the immune system has shown to immediately react to situations of social evaluation in experimental research (Muscatell et al., 2016), it is plausible to assume that the adverse effects of intensified social comparisons and low social cohesion can manifest biologically within short time periods.

Additionally, non-random allocation of individuals to their respective spatial contexts presents one of the major challenges in research on contextual effects. Explicitly modelling neighbourhood selection decisions, individual/household income and ethnicity emerged as the main drivers of neighbourhood choice in previous studies (Hedman et al., 2011; Musterd et al., 2016; Troost et al., 2021). Although we do not explicitly take account of neighbourhood selection, including equivalised income at wave 5 into our models did decrease estimated p-values for cross-level interactions in Model 2 and interpretation of main results was not affected. We were not able to explore potential confounding of our associations by ethnicity due to data limitations and note that these are not due to sampling issues but due to the underlying population of western Scotland. Still, we may hypothesise about possible confounding pathways. First, previous UK-based research on intersectional inequalities in CRP has indicated Chinese and Caribbean groups to have lower average CRP levels than white British groups, whereas Pakistani, Indian, and African groups have higher average CRP levels than White British groups (Holman et al., 2022). Thus, omitting individual-level ethnicity may induce both positive and negative confounding of the relationship between SEP and hs-CRP depending on the relevant ethnic groups. Second, we assume that ethnic minority groups are more likely to live in areas wherein a majority of the population are in disadvantaged SEPs. Because of the 'ethnic density effect' (Bécares et al., 2018) (the observation that residential concentration of ethnic minorities is protective for their health), not accounting for neighbourhood selection based on ethnicity may induce positive confounding and thus would lead to an underestimation of our estimated effect heterogeneity by status inequality. Third, neighbourhood selection based on ethnicity could additionally confound the association between the mediator of the moderator-outcome relationship (social cohesion) and the outcome hs-CRP. Social cohesion and social support have been used as potential explanations for the 'ethnic density effect' (Bécares et al., 2018). In this mediating role, including ethnicity may reduce the strength of the mediated moderation as ethnic minorities select themselves into residential areas with higher social cohesion as a consequence of selection based on the spatial distribution of ethnic minorities.

Another salient issue is the identification of the relevant spatial unit. Although we estimated associations on four spatial levels, it is plausible that not one single contextual unit is identified as relevant since socio-spatial mechanisms are unlikely to abruptly change at the border of an (administrative) spatial unit, but rather may follow a (non-linear) distance function (Petrović et al., 2022). Studies which move beyond administrative units by using 'bespoke neighbourhoods' may come closer to the relevant spatial context (Petrović et al., 2020). Using individual perception of social cohesion within neighbourhoods may shift the definition of neighbourhood towards study participants' perception. This operationalisation, however, contradicts the contextual conceptualisation of social cohesion and makes it difficult to discern the effect of social cohesion from unobserved individual level traits that may drive the perception of social cohesion (and the outcome of interest) (Oberndorfer et al., 2022). Our data only facilitated a low contextual-level reliability of our social cohesion measurement due to a low number of participants nested within the same spatial units. Restricting our analyses to spatial units with more than one study participant increased the contextual level reliability of our measurement but did not change our results.

We assumed that the reference groups individuals use for status comparisons are tied to places; at least to a degree that is relevant for a detectable context-dependency in chronic activation of the stress-response leading to higher hs-CRP. Although previous empirical studies only partly support 'neighbours' as appropriate reference group (Gugushvili, 2021), complementary analysis indicated that participants' self-assessed social status is dependent on the status distribution in their area of residence. In our data, there was a stronger association between self-assessed status and hs-CRP than occupational group and hs-CRP.

Furthermore, our study was limited to a single hs-CRP measurement of participants which could have induced measurement error. As intra-individual variability in hs-CRP among (older) adults has shown to be low to moderate (Lassale et al., 2019; Ockene et al., 2001), the effect of this potential measurement error on our results is limited.

Lastly, uncertainty around our estimates of cross-level interaction terms was often high. Most studies are severely underpowered to detect cross-level interactions. It has thus been suggested that an alpha = 0.05 level of statistical significance may be too low for cross-level interaction effects (Mathieu et al., 2012). With this limitation in mind, we avoided an emphasis on p-values when interpreting our estimates and note that our presentation of 95% confidence intervals could even be seen as conservative (Mathieu et al., 2012).

5. Conclusion

Adopting a geographical lens on the psychosocial causes of health inequalities, our study suggests that the well documented association between socioeconomic position and systemic chronic inflammation is heavily context-dependent. Characteristics of the social environment individuals live in may play a vital role in the biological embodiment of social disadvantage. Socioeconomic inequalities in systemic chronic inflammation were greatest among study participants living in areas wherein a majority of residents are in advantaged socioeconomic positions and contextual-level social cohesion was low. In other combinations of these contextual characteristics, socioeconomic inequalities in systemic chronic inflammation were not detectable or potentially even reversed. Importantly, flexible specification of cross-level interactions, although causing higher uncertainty around estimates, indicated that individual-level socioeconomic position, contextual-level status inequality, and social cohesion interact in asymmetrical ways that support and contradict existing theoretical propositions.

By focusing on associations in a cross-sectional setting, our study has only scratched the surface of the complexities likely to be discovered in longitudinal studies (Crielaard et al., 2021). Concerning future research on the psychosocial causes of health inequalities, our study thus points to a hardly surprising takeaway message: the same socioeconomic position can have different consequences for health contingent on not only individual-level characteristics but also on features of the social environment. Knowledge of the contextual conditions under which we expect a disadvantaged socioeconomic position to be more or less detrimental for health is crucial for successful reductions of health inequalities. The existence and direction of these contextual effects are likely to be conditional on individual-level characteristics, geography, and time. These conditionalities of contextual effects should be embraced by precise theoretical propositions guiding empirical research. After all, to be valuable, contextual effects do not need to be universal.

Author contributions

MO conceived the study. MO, IG, TED were involved in funding acquisition for this study (MPC-2021-00178). MO, AHL, JP were involved in the methodology and study design. MO, MKH prepared the data. MO analysed the data and created visualisations. MO wrote the initial draft of this manuscript. MO, AHL, JP, IG, MKH, TED provided critical feedback on multiple iterations of this manuscript and approved the submitted version.

Declaration of competing interest

None.

Data availability

Twenty07 data sharing policy and application form for collaborations with bona fide researchers is at http://2007study.sphsu.mrc.ac.uk/. Statistical code will be published on the author's github.com

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.116185.

References

Bécares, L., Dewey, M.E., Das-Munshi, J., 2018. Ethnic density effects for adult mental health: systematic review and meta-analysis of international studies. Psychol. Med. 48 (12), 2054–2072. https://doi.org/10.1017/S0033291717003580.

Benzeval, M., Der, G., Ellaway, A., et al., 2009. Cohort profile: West of Scotland twenty-07 study: health in the community. Int. J. Epidemiol. 38 (5), 1215–1223. https://doi.org/10.1093/ije/dyn213.

Berger, E., Castagné, R., Chadeau-Hyam, M., et al., 2019. Multi-cohort study identifies social determinants of systemic inflammation over the life course. Nat. Commun. 10 (1), 1–10. https://doi.org/10.1038/s41467-019-08732-x.

Buttrick, N.R., Oishi, S., 2017. The psychological consequences of income inequality. Soc. Pers. Psychol. Compass 11 (3), e12304. https://doi.org/10.1111/spc3.12304.

Castagné, R., Delpierre, C., Kelly-Irving, M., et al., 2016a. A life course approach to explore the biological embedding of socioeconomic position and social mobility through circulating inflammatory markers. Sci. Rep. 6 (1), 1–10. https://doi.org/10.1038/srep25170.

Castagné, R., Kelly-Irving, M., Campanella, G., et al., 2016b. Biological marks of early-life socioeconomic experience is detected in the adult inflammatory transcriptome. Sci. Rep. 6 (1), 1–10. https://doi.org/10.1038/srep38705.

Clark, C.R., Ridker, P.M., Ommerborn, M.J., et al., 2012. Cardiovascular inflammation in healthy women: multilevel associations with state-level prosperity, productivity and income inequality. BMC Publ. Health 12 (1), 211. https://doi.org/10.1186/1471-2458-12-211.

Crielaard, L., Nicolaou, M., Sawyer, A., Quax, R., Stronks, K., 2021. Understanding the impact of exposure to adverse socioeconomic conditions on chronic stress from a complexity science perspective. BMC Med. 19 (1), 242. https://doi.org/10.1186/s12916-021-02106-1.

Davillas, A., Benzeval, M., Kumari, M., 2017. Socio-economic inequalities in C-reactive protein and fibrinogen across the adult age span: findings from Understanding Society. Sci. Rep. 7 (1), 2641. https://doi.org/10.1038/s41598-017-02888-6.

Delhey, J., Steckermeier, L.C., 2020. Social ills in rich countries: new evidence on levels, causes, and mediators. Soc. Indicat. Res. 149 (1), 87–125. https://doi.org/10.1007/s11205-019-02244-3.

Der, G., 1998. A Comparison of the West of Scotland Twenty-07 Study Sample and the 1991 Census SARs. Published online.

Furman, D., Campisi, J., Verdin, E., et al., 2019. Chronic inflammation in the etiology of disease across the life span. Nat. Med. 25 (12), 1822–1832. https://doi.org/10.1038/s41591-019-0675-0.

Galster, G.C., 2012. The mechanism(s) of neighbourhood effects: theory, evidence, and policy implications. In: van Ham, M., Manley, D., Bailey, N., Simpson, L., Maclennan, D. (Eds.), Neighbourhood Effects Research: New Perspectives. Springer Netherlands, pp. 23–56. https://doi.org/10.1007/978-94-007-2309-2_2.

Gerber, J.P., Wheeler, L., Suls, J., 2018. A social comparison theory meta-analysis 60+ years on. Psychol. Bull. 144 (2), 177–197. https://doi.org/10.1037/bul0000127.

Goldthorpe, J.H., 2010. Review article: analysing social inequality: a critique of two recent contributions from economics and epidemiology. Eur. Socio Rev. 26 (6), 731–744.

Gugushvili, A., 2021. Which socio-economic comparison groups do individuals choose and why? Eur. Soc. 23 (4), 437–463. https://doi.org/10.1080/14616696.2020.1793214.

Hedman, L., van Ham, M., Manley, D., 2011. Neighbourhood choice and neighbourhood reproduction. Environ. Plann. 43 (6), 1381–1399. https://doi.org/10.1068/a43453.

Holman, D., Bell, A., Green, M., Salway, S., 2022. Neighbourhood deprivation and intersectional inequalities in biomarkers of healthy ageing in England. Health Place 77, 102871. https://doi.org/10.1016/j.healthplace.2022.102871.

Holmes, L.M., Marcelli, E.A., 2012. Neighborhoods and systemic inflammation: high CRP among legal and unauthorized Brazilian migrants. Health Place 18 (3), 683–693. https://doi.org/10.1016/j.healthplace.2011.11.006.

Hu, Y., van Lenthe, F.J., Mackenbach, J.P., 2015. Income inequality, life expectancy and cause-specific mortality in 43 European countries, 1987–2008: a fixed effects study. Eur. J. Epidemiol. 30 (8), 615–625. https://doi.org/10.1007/s10654-015-0066-x.

Kawachi, I., Kennedy, B.P., 1997. Health and social cohesion: why care about income inequality? BMJ 314 (7086), 1037–1040.

Kawachi, I., Kennedy, B.P., 1999. Income inequality and health: pathways and mechanisms. Health Serv. Res. 34 (1 Pt 2), 215–227.

Knight, E.L., Mehta, P.H., 2017. Hierarchy stability moderates the effect of status on stress and performance in humans. Proc. Natl. Acad. Sci. USA 114 (1), 78–83. https://doi.org/10.1073/pnas.1609811114.

Kondo, N., Sembajwe, G., Kawachi, I., Dam, RM van, Subramanian, S.V., Yamagata, Z., 2009. Income inequality, mortality, and self rated health: meta-analysis of multilevel studies. BMJ 339. https://doi.org/10.1136/bmj.b4471.

Kraus, M.W., Tan, J.J.X., Tannenbaum, M.B., 2013. The social ladder: a rank-based perspective on social class. Psychol. Inq. 24 (2), 81–96. https://doi.org/10.1080/1047840X.2013.778803.

Kraus, M.W., Park, J.W., Tan, J.J.X., 2017. Signs of social class: the experience of economic inequality in everyday life. Perspect. Psychol. Sci. 12 (3), 422–435. https://doi.org/10.1177/1745691616673192.

Kubzansky, L.D., Seeman, T.E., Glymour, M.M., 2014. Biological pathways linking social conditions and health. Plausible mechanisms and emerging puzzles. In: second ed. Social Epidemiology. Oxford University Press, pp. 512–561.

Lassale, C., Batty, G.D., Steptoe, A., et al., 2019. Association of 10-year C-reactive protein trajectories with markers of healthy aging: findings from the English longitudinal study of aging. J. Gerontol.: Series A. 74 (2), 195–203. https://doi.org/10.1093/gerona/gly028.

Layte, R., Whelan, C.T., 2014. Who feels inferior? A test of the status anxiety hypothesis of social inequalities in health. Eur. Socio Rev. 30 (4), 525–535. https://doi.org/10.1093/esr/jcu057.

Layte, R., McCrory, C., Cheallaigh, C.N., et al., 2019. A comparative analysis of the status anxiety hypothesis of socio-economic inequalities in health based on 18,349 individuals in four countries and five cohort studies. Sci. Rep. 9 (1), 1–12. https://doi.org/10.1038/s41598-018-37440-7.

Leyland, A.H., Groenewegen, P.P., 2020. Multilevel Modelling for Public Health and Health Services Research: Health in Context. Springer International Publishing. https://doi.org/10.1007/978-3-030-34801-4.

Liu, R.S., Aiello, A.E., Mensah, F.K., et al., 2017a. Socioeconomic status in childhood and C reactive protein in adulthood: a systematic review and meta-analysis. J. Epidemiol. Commun. Health 71 (8), 817–826. https://doi.org/10.1136/jech-2016-208646.

Liu, Y.Z., Wang, Y.X., Jiang, C.L., 2017b. Inflammation: the common pathway of stress-related diseases. Front. Hum. Neurosci. 11 https://doi.org/10.3389/fnhum.2017.00316.

Lynch, J., Smith, G.D., 2002. Commentary: income inequality and health: the end of the story? Int. J. Epidemiol. 31 (3), 549–551. https://doi.org/10.1093/ije/31.3.549.
Lynch, J., Smith, G.D., Hillemeier, M., Shaw, M., Raghunathan, T., Kaplan, G., 2001. Income inequality, the psychosocial environment, and health: comparisons of wealthy nations. Lancet 358 (9277), 194–200. https://doi.org/10.1016/S0140-6736(01)05407-1.
Lynch, J., Smith, G.D., Harper, S., et al., 2004. Is income inequality a determinant of population health? Part 1. A systematic review. Milbank Q. 82 (1), 5–99. https://doi.org/10.1111/j.0887-378X.2004.00302.x.
Mackenbach, J.P., 2012. The persistence of health inequalities in modern welfare states: the explanation of a paradox. Soc. Sci. Med. 75 (4), 761–769. https://doi.org/10.1016/j.socscimed.2012.02.031.
Marmot, M.G., Sapolsky, R., 2014. Of Baboons and Men: Social Circumstances, Biology, and the Social Gradient in Health. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK242456/. (Accessed 26 August 2020).
Marsland, A.L., Walsh, C., Lockwood, K., John-Henderson, N.A., 2017. The effects of acute psychological stress on circulating and stimulated inflammatory markers: a systematic review and meta-analysis. Brain Behav. Immun. 64, 208–219. https://doi.org/10.1016/j.bbi.2017.01.011.
Mathieu, J.E., Aguinis, H., Culpepper, S.A., Chen, G., 2012. Understanding and estimating the power to detect cross-level interaction effects in multilevel modeling. J. Appl. Psychol. 97 (5), 951–966. https://doi.org/10.1037/a0028380.
McCartney, G., Hoggett, R., Walsh, D., Lee, D., 2023. How well do area-based deprivation indices identify income- and employment-deprived individuals across Great Britain today? Publ. Health 217, 22–25. https://doi.org/10.1016/j.puhe.2023.01.020.
Muntaner, C., Lynch, J., 1999. Income inequality, social cohesion, and class relations: a critique of Wilkinson's neo-Durkheimian research program. Int. J. Health Serv. 29 (1), 59–81. https://doi.org/10.2190/G8QW-TT09-67PL-QTNC.
Muntaner, C., Lynch, J., Oates, G.L., 1999. The social class determinants of income inequality and social cohesion. Int. J. Health Serv. 29 (4), 699–732. https://doi.org/10.2190/HNC9-BEFF-7UWL-92Y2.
Muscatell, K.A., Eisenberger, N.I., 2012. A social neuroscience perspective on stress and health. Soc Personal Psychol Compass 6 (12), 890–904. https://doi.org/10.1111/j.1751-9004.2012.00467.x.
Muscatell, K.A., Dedovic, K., Slavich, G.M., et al., 2016. Neural mechanisms linking social status and inflammatory responses to social stress. Soc. Cognit. Affect Neurosci. 11 (6), 915–922. https://doi.org/10.1093/scan/nsw025.
Muscatell, K.A., Brosso, S.N., Humphreys, K.L., 2018. Socioeconomic status and inflammation: a meta-analysis. Mol. Psychiatr. 1–11. https://doi.org/10.1038/s41380-018-0259-2. Published online October 19.
Musterd, S., van Gent, W.P., Das, M., Latten, J., 2016. Adaptive behaviour in urban space: residential mobility in response to social distance. Urban Stud. 53 (2), 227–246. https://doi.org/10.1177/0042098014562344.
Nazmi, A., Roux, A.D., Ranjit, N., Seeman, T.E., Jenny, N.S., 2010. Cross-sectional and longitudinal associations of neighborhood characteristics with inflammatory markers: findings from the Multi-Ethnic Study of Atherosclerosis. Health Place 16 (6), 1104–1112. https://doi.org/10.1016/j.healthplace.2010.07.001.
Neergheen, V.L., Topel, M., Van Dyke, M.E., et al., 2019. Neighborhood social cohesion is associated with lower levels of interleukin-6 in African American women. Brain Behav. Immun. 76, 28–36. https://doi.org/10.1016/j.bbi.2018.10.008.
Nguyen, A.W., Taylor, H.O., Lincoln, K.D., et al., 2022. Neighborhood characteristics and inflammation among older black Americans: the moderating effects of hopelessness and pessimism. J. Gerontol.: Series A. 77 (2), 315–322. https://doi.org/10.1093/gerona/glab121.
Norton, M.I., 2013. All ranks are local: why humans are both (painfully) aware and (surprisingly) unaware of their lot in life. Psychol. Inq. 24 (2), 124–125. https://doi.org/10.1080/1047840X.2013.794689.
Oberndorfer, M., Dorner, T.E., Leyland, A.H., et al., 2022. The challenges of measuring social cohesion in public health research: a systematic review and ecometric meta-analysis. SSM - Population Health 17, 101028. https://doi.org/10.1016/j.ssmph.2022.101028.
Ockene, I.S., Matthews, C.E., Rifai, N., Ridker, P.M., Reed, G., Stanek, E., 2001. Variability and classification accuracy of serial high-sensitivity C-reactive protein measurements in healthy adults. Clin. Chem. 47 (3), 444–450. https://doi.org/10.1093/clinchem/47.3.444.
HMSO. Opsc, 1980. Classification of Occupations 1980.
Paskov, M., Richards, L., 2021. Social status inequality and depression in Europe. Int. J. Comp. Sociol. 62 (2), 93–114. https://doi.org/10.1177/00207152211022419.
Patel, V., Burns, J.K., Dhingra, M., Tarver, L., Kohrt, B.A., Lund, C., 2018. Income inequality and depression: a systematic review and meta-analysis of the association and a scoping review of mechanisms. World Psychiatr. 17 (1), 76–89. https://doi.org/10.1002/wps.20492.
Petrović, A., Manley, D., van Ham, M., 2020. Freedom from the tyranny of neighbourhood: rethinking sociospatial context effects. Prog. Hum. Geogr. 44 (6), 1103–1123. https://doi.org/10.1177/0309132519868767.
Petrović, A., van Ham, M., Manley, D., 2022. Where do neighborhood effects end? Moving to multiscale spatial contextual effects. Ann. Assoc. Am. Geogr. 112 (2), 581–601. https://doi.org/10.1080/24694452.2021.1923455.
Pickett, K.E., Wilkinson, R.G., 2015. Income inequality and health: a causal review. Soc. Sci. Med. 128, 316–326. https://doi.org/10.1016/j.socscimed.2014.12.031.
Portes, A., 2014. Downsides of social capital. Proc. Natl. Acad. Sci. U.S.A. 111 (52), 18407–18408. https://doi.org/10.1073/pnas.1421888112.
Powell, N.D., Sloan, E.K., Bailey, M.T., et al., 2013. Social stress up-regulates inflammatory gene expression in the leukocyte transcriptome via β-adrenergic induction of myelopoiesis. Proc. Natl. Acad. Sci. USA 110 (41), 16574–16579. https://doi.org/10.1073/pnas.1310655110.
Raudenbush, S.W., Sampson, R.J., 1999. Ecometrics: toward a science of assessing ecological settings, with application to the systematic social observation of neighborhoods. Socio. Methodol. 29, 1–41.
Ridker, P.M., 2016. A test in context: high-sensitivity C-reactive protein. J. Am. Coll. Cardiol. 67 (6), 712–723. https://doi.org/10.1016/j.jacc.2015.11.037.
Robertson, T., Popham, F., Benzeval, M., 2014. Socioeconomic position across the lifecourse & allostatic load: data from the West of Scotland Twenty-07 cohort study. BMC Publ. Health 14 (1), 184. https://doi.org/10.1186/1471-2458-14-184.
Rodriguez-Bailon, R., Sanchez-Rodriguez, A., Garcia-Sanchez, E., Petkanopoulou, K., Willis, G.B., 2020. Inequality is in the air: contextual psychosocial effects of power and social class. Curr Opin Psychol 33, 120–125. https://doi.org/10.1016/j.copsyc.2019.07.004.
Rose, D., Pevalin, D.J., O'Reilly, K., 2005. The National Statistics Socio-Economic Classification: Origins, Development, and Use. Palgrave Macmillan.
Sampson, R.J., 2012. Great American City: Chicago and the Enduring Neighborhood Effect. Univ. of Chicago Press.
Sampson, R.J., Raudenbush, S.W., Earls, F., 1997. Neighborhoods and violent crime: a multilevel study of collective efficacy. Science 277 (5328), 918–924. https://doi.org/10.1126/science.277.5328.918.
Schiefer, D., Noll, J., 2017. The essentials of social cohesion: a literature review. Soc. Indicat. Res.: An Int. Interdiscipl. J. Qual.-Life Meas. 132 (2), 579–603.
Seaman, S., Benzeval, M., 2011. The West of Scotland Twenty-07 Study: Inverse Probability Weights for Wave 5. MRC/CSO Social and Public Health Sciences Unit Working Paper 27, Glasgow. Published online.
Segerstrom, S.C., Miller, G.E., 2004. Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. Psychol. Bull. 130 (4), 601–630. https://doi.org/10.1037/0033-2909.130.4.601.
Shaw, M., Galobardes, B., Lawlor, D.A., Lynch, J., Wheeler, B., Smith, G.D. (Eds.), 2007. The Handbook of Inequality and Socioeconomic Position. Policy.
Slavich, G.M., Cole, S.W., 2013. The emerging field of human social genomics. Clin. Psychol. Sci. 1 (3), 331–348.
Slavich, G.M., Irwin, M.R., 2014. From stress to inflammation and major depressive disorder: a social signal transduction theory of depression. Psychol. Bull. 140 (3), 774–815. https://doi.org/10.1037/a0035302.
The Emerging Risk Factors Collaboration, 2010. C-reactive protein concentration and risk of coronary heart disease, stroke, and mortality: an individual participant meta-analysis. Lancet 375 (9709), 132–140. https://doi.org/10.1016/S0140-6736(09)61717-7.
Troost AA, van Ham M, Janssen HJ. Modelling neighbourhood effects in three Dutch cities controlling for selection. Appl Spatial Analysis. Published online August 24, 2021. doi:10.1007/s12061-021-09411-5.
VanderWeele, T., 2015. Explanation in Causal Inference: Methods for Mediation and Interaction. Oxford University Press.
Villalonga-Olives, E., Kawachi, I., 2017. The dark side of social capital: a systematic review of the negative health effects of social capital. Soc. Sci. Med. 194, 105–127. https://doi.org/10.1016/j.socscimed.2017.10.020.
Vineis, P., Delpierre, C., Castagné, R., et al., 2020. Health inequalities: embodied evidence across biological layers. Soc. Sci. Med. 246, 112781 https://doi.org/10.1016/j.socscimed.2019.112781.
Wilkinson, R.G., 1997. Unhealthy Societies: the Afflictions of Inequality. Routledge.
Wilkinson, R.G., Pickett, K.E., 2006. Income inequality and population health: a review and explanation of the evidence. Soc. Sci. Med. 62 (7), 1768–1784. https://doi.org/10.1016/j.socscimed.2005.08.036.
Wilkinson, R.G., Pickett, K., 2010. The spirit level: why equality is better for everyone ; [with a new chapter responding to their critics]. In: Published with Revisions, Published with a New Postscript. Penguin Books.
Wilkinson, R.G., Pickett, K.E., 2017. The enemy between us: the psychological and social costs of inequality. Eur. J. Soc. Psychol. 47 (1), 11–24. https://doi.org/10.1002/ejsp.2275.
Wilkinson, R.G., Pickett, K., 2018. The Inner Level: How More Equal Societies Reduce Stress, Restore Sanity and Improve Everyone's Well-Being. Allen Lane.
Zell, E., Alicke, M.D., 2010. The local dominance effect in self-evaluation: evidence and explanations. Pers. Soc. Psychol. Rev. 14 (4), 368–384. https://doi.org/10.1177/1088868310366144.
Zell, E., Lesick, T.L., 2021. Taking social comparison to the extremes: the huge-fish-tiny-pond effect in self-evaluations. Soc. Psychol. Personal. Sci. 12 (6), 1030–1038. https://doi.org/10.1177/1948550620956535.